ET55

ELECTRICAL WORKERS REGISTRATION BOARD

SAFETY | COMPETENCY | COMPLIANCE

Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

14 November 2015

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have **10 minutes** to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

(a) A new 230V electrical installation incorporates permanently-connected electrical equipment with **MIMS elements**.

(i) State the permitted test result for an insulation resistance test for the electrical installation with **all** the permanently-connected electrical equipment **disconnected**.

(1 mark)

____

(ii) State the permitted test result for an insulation resistance test for the electrical installation with **all** the permanently-connected electrical equipment **connected**.

(1 mark)

____

(b) (i) A three-phase induction motor normally runs on full-load. State **ONE** reason why this motor should not be run **lightly loaded** when it normally runs on full load.

(1 mark)

____

____

(ii) A three-phase induction motor has been **operating normally on full-load**. The motor starts to over-heat even though it is drawing the normal full load current.

State **ONE** reason why this situation would occur.

(1 mark)

____

____

(turn over)

Question 1 continued

(c) A clip-on ammeter is being used to test the integrity of the insulation of a **repaired** Class I electrical appliance, while the appliance is **live**.

(i) Where on the appliance would the clip-on ammeter be used?

(1 mark)

____

(ii) State the maximum test result that would allow the appliance to be returned to service.

(1 mark)

____

(d) Explain what is meant by the term **inverse time-current characteristic** in relation to protective devices?

(2 marks)

____

____

____

____

(e) State **TWO** components that are typically used to smooth the d.c. output of a rectifier.

(2 marks)

(1) ____

(2) ____

(turn over)

Question 1 continued

(f) The output circuit of an autotransformer **must be** insulated for the highest input or output voltage of the autotransformer.

State **ONE** reason for this requirement.

(2 marks)

____

____

____

____

(g) A Class I, plug-in electric heater is designed for use on 230V/240V supply. An ohmmeter reads 24 Ω when measured at the plug.

Use calculations to show the supply voltage being used if the power dissipated is 2204W.

(2 marks)

(h) An isolator for 230V electrical equipment has been replaced. During the work the **phase (active) and neutral** were accidentally transposed at the **supply side** of the isolating switch.

What potential danger would this transposition create?

(2 marks)

____

____

____

(turn over)

Question 1 continued

(i) (i) State **ONE** formula used to determine the **power factor** of a three-phase **inductive** load.

(1 mark)

____

(ii) State **ONE** formula used to determine the **resistance** of a single-phase **resistive** load if the power and voltage are known.

(1 mark)

____

(j) (i) What do the initials **BJT** mean when applied to semiconductors?

(1 mark)

____

____

(ii) State the function of a **transducer**.

(1 mark)

____

____

____

(turn over)

Question 2

Introduction

One HRC fuse protecting the final subcircuit supplying a concrete-making vibrating plant has blown (operated).

The plant is driven by a permanently-connected, 400V, three-phase, 1.5 kW induction motor controlled by a DOL starter. The motor and starter are controlled by an adjacent isolator.

The **motor has been isolated** and the isolator has been locked off and tagged.

Initial testing shows that there is no fault between the switchboard and the load side of the DOL starter.

Use the information in the introduction to this question to answer parts 2(a), 2(b) and 2(c).

(turn over)

Question 2 continued

(a) An insulation resistance test is to be carried out on the cables supplying the motor and the motor itself.

Describe how this testing is carried out and include:

- What cables/windings need to be disconnected or separated.
- The test instrument used.
- The test voltage applied.
- The test result expected for the fault.

(6 marks)

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

(turn over)

Question 2 continued

(b) (i) The fault has been rectified and the motor has been tested and reconnected to the DOL starter **but not livened**.

Testing has to be carried out to ensure the motor is effectively connected to the MEN earthing system.

Describe how this testing is carried out and include:

- The test instrument used
- The test result that will allow the motor to be re-commissioned

(2 marks)

____

____

____

____

____

____

(ii) State what the test carried out in (b)(i) verifies.

(1 mark)

____

____

____

____

(c) State **ONE** instrument test that should be carried out **after** the motor is livened.

(1 mark)

____

(turn over)

Question 3

Introduction

A new three-phase water heater has been installed in an industrial installation to replace an existing water heater. The water heater has three elements rated at 400V, each with a resistance of 30Ω. The elements can be connected either in star or delta.

Use the information in the introduction to this question to answer parts 3(a) and 3(b).

(a) (i) Calculate power consumed by the water heater when the **elements are connected in star**.

(4 marks)

(ii) Select the minimum size final subcircuit TPS cable that can supply the water heater when the **elements are connected in star**.

(½ mark)

____

(iii) Select the minimum HRC fuses that can protect the final subcircuit selected in (a)(ii) for the water heater when the **elements are connected in star**.

(½ mark)

____

(turn over)

Question 3 continued

(b) (i) Calculate the power consumed by the water heater when the **elements are connected in delta**.

(4 marks)

(ii) Select the minimum size final subcircuit TPS cable that can supply the water heater when the **elements are connected in delta**.

(½ mark)

____

(iii) Select the minimum size HRC fuses that can protect the final subcircuit selected in (b)(ii) for the water heater when the **elements are connected in delta**.

(½ mark)

____

(turn over)

Question 4

(a) Figure 1 is a diagram of a 230V, single-tube fluorescent light fitting.

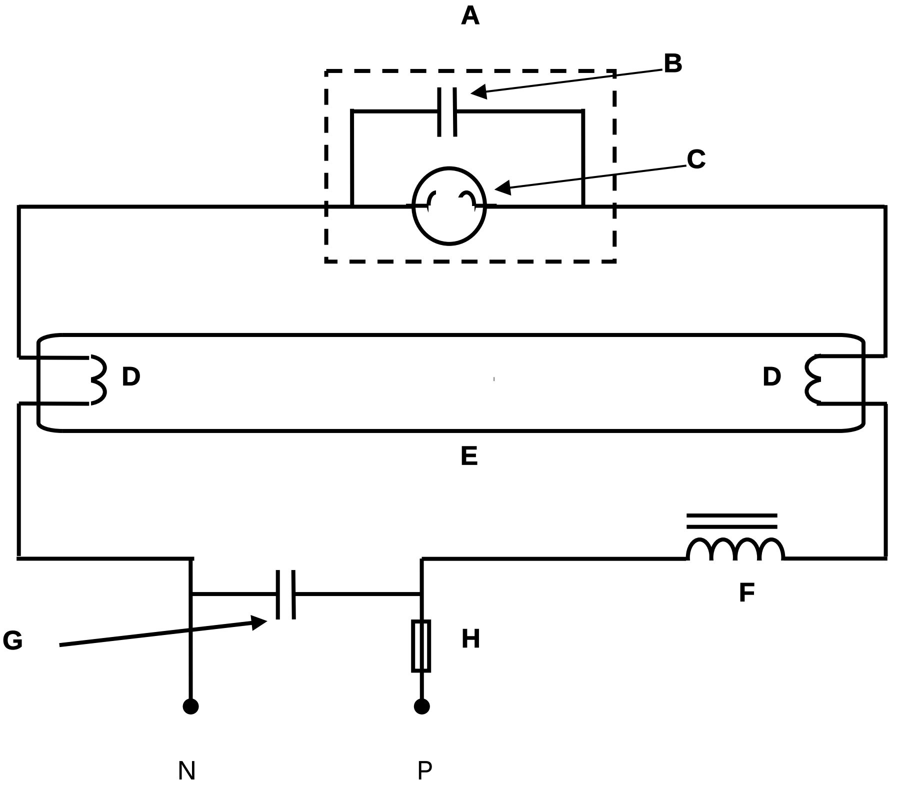


Figure 1

(i) Name the components of the fluorescent light fitting.

(4 marks)

A ____

B ____

C ____

D ____

E ____

F ____

G ____

H ____

(turn over)

Question 4 continued

(ii) State **ONE** function of **Component B** in Figure 1.

(1 mark)

____

____

____

(iii) State **ONE** function of **Component F** in Figure 1.

(1 mark)

____

____

____

(b) (i) Describe the **basic operation** of a gas discharge lamp.

(2 marks)

____

____

____

____

(ii) Name **TWO** types of gas discharge lamps.

(1 mark)

(1) ____

(2) ____

(turn over)

Question 4 continued

(c) State **TWO** requirements for good illumination.

(1 mark)

(1) ____

____

(2) ____

____

(turn over)

Question 5

(a) (i) Explain why **rewireable fuses** are classed as **coarse excess current** protection.

(2 marks)

____

____

____

____

(ii) Explain why **gG type HRC fuses and MCBs** are classed as **close current protection**.

(2 marks)

____

____

____

____

(turn over)

Question 5 continued

(b) The total time taken for a HRC fuse to operate is defined as the total operating (or clearance) time. The total clearance time comprises the **pre-arcing time** and the **arcing time**.

(i) Define the term **pre-arcing time**.

(2 marks)

____

____

____

____

____

(ii) Define the term **arcing time**.

(2 marks)

____

____

____

____

____

(c) Describe how **correct discrimination** is achieved between protective devices in an electrical installation.

(2 marks)

____

____

____

(turn over)

Question 6

(a) A MEN, low voltage electrical installation operates at standard low voltage.

(i) What type of switchboard must be electrically closest to the point of supply?

(½ mark)

____

(ii) To which parts of the electrical installation are the ends of the main earthing conductor connected?

(1 mark)

____

____

(iii) What is required to be attached at one end of the main earthing conductor?

(½ mark)

____

(b) State **SEVEN** components of an MEN system that are found in a **MEN switchboard** in a low voltage electrical installation.

(3½ marks)

(1) ____

(2) ____

(3) ____

(4) ____

(5) ____

(6) ____

(7) ____

(turn over)

Question 6 continued

(c) State the **THREE** points in an MEN system that are earthed.

(1½ marks)

(1) ____

(2) ____

(3) ____

(d) In a low voltage electrical installation the following readings were obtained:

No. 1 final socket outlet subcircuit	0.32Ω earth loop impedance
No. 2 final socket outlet subcircuit	0.58Ω earth loop impedance

A fault of negligible impedance occurred in each final subcircuit.

Calculate **how much more** fault current would flow under the fault conditions in No. 1 final subcircuit than the fault current that would flow in No. 2 final subcircuit.

(3 marks)

(turn over)

Question 7

(a) Draw and label the circuit diagram of the **230V** DOL starter control circuit. The control circuit incorporates electrical protection.

- The motor is protected by thermal overloads.
- The motor control circuit incorporates an interlock (the motor will not start if the electrical equipment safety covers are not in place).

You do not need to show the power circuit of the installation.

(5 marks)

(turn over)

Question 7 continued

(b) A remote start/stop station has been installed for a DOL starter controlling a three-phase induction motor.

State the effect on the operation of the motor if the stop button in the remote stop/start station was connected in parallel with the stop button of the DOL starter.

(2 marks)

____

____

____

____

(c) A DOL starter has been rewired. When the start button is pushed on the DOL starter the contactor closes, but as soon as the start button is released the contactor drops out.

State **ONE** reason why this situation would occur.

(1 mark)

____

____

____

(d) Electronic starters are often used with three-phase a.c. induction motors. Explain how the operation of an a.c. variable speed controller is different to the operation of an electronic soft starter.

(2 marks)

____

____

____

____

____

____

(turn over)

Question 8

Introduction

A 230V transformer with a step-down ratio of 19:1 is used to supply electric toys. The transformer has 2000 turns on the primary.

The transformer is rated at 25 VA. Ignore any losses.

Use the information in the introduction to this question to answer parts 8(a), 8(b), 8(c), 8(d) and 8(e).

(a) Calculate the **maximum primary current** of the transformer.

(2 marks)

(b) Calculate the number of **secondary turns** of the transformer.

(2 marks)

(c) Calculate the **secondary voltage** of the transformer.

(2 marks)

(turn over)

Question 8 continued

(d) Calculate the **maximum secondary current** of the transformer.

(2 marks)

(e) Calculate the **volts per turn** of the transformer.

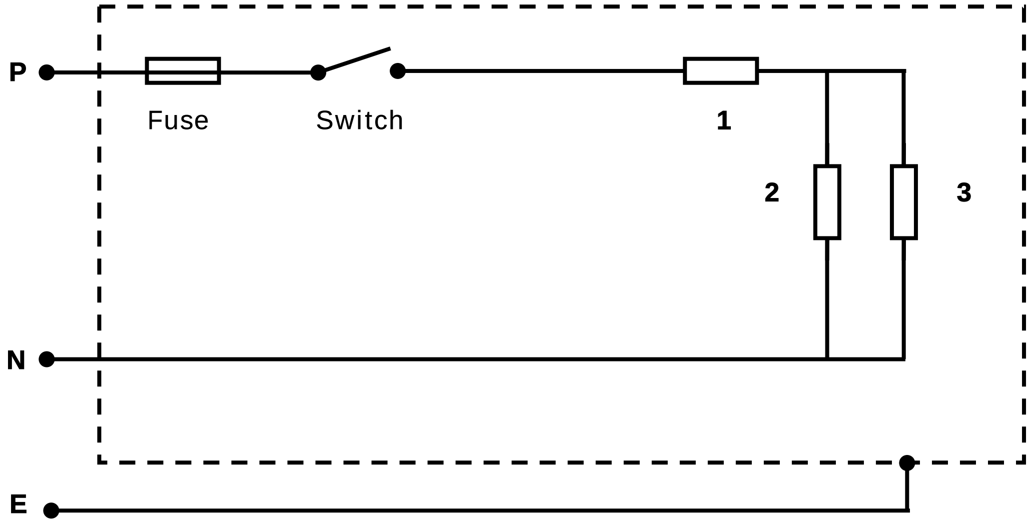
(2 marks)

(turn over)

Question 9

Introduction

The figure below represents a 230V, Class I, portable oven. The oven is rated at 2000W.



- Element 1 is 6.62Ω.
- Element 2 is 59.4 Ω

Use the information in the introduction to this question to answer parts 9(a) and 9(b).

(turn over)

Question 9 continued

(a) Calculate the power consumed by **element 1.**

(5 marks)

(turn over)

Question 9 continued

(b) Element 3 is faulty and requires replacing. To order a replacement both the rating and resistance of element 3 are required.

(i) Calculate the **rating** of **element 3** in watts.

(3½ marks)

(ii) Calculate the **resistance** of **element 3**.

(1½ marks)

For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner's Use Only		
Questions Answered	**Marks**	
1		
2		
3		
4		
5		
6		
7		
8		
9		
TOTAL		